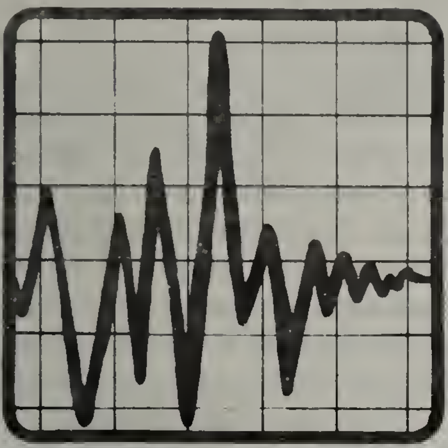


Earthquakes in the Illinois area

People living in northern Illinois might be surprised when a discussion of civil emergencies includes earthquakes. Tremors rarely occur in their part of the state. Travel southward, though, and the topic is more acceptable. Most people have felt tremors once or twice in a lifetime. Those living along the southern borders are especially concerned—because just south of Illinois lies the New Madrid seismic zone, the most active earthquake area in the central United States.

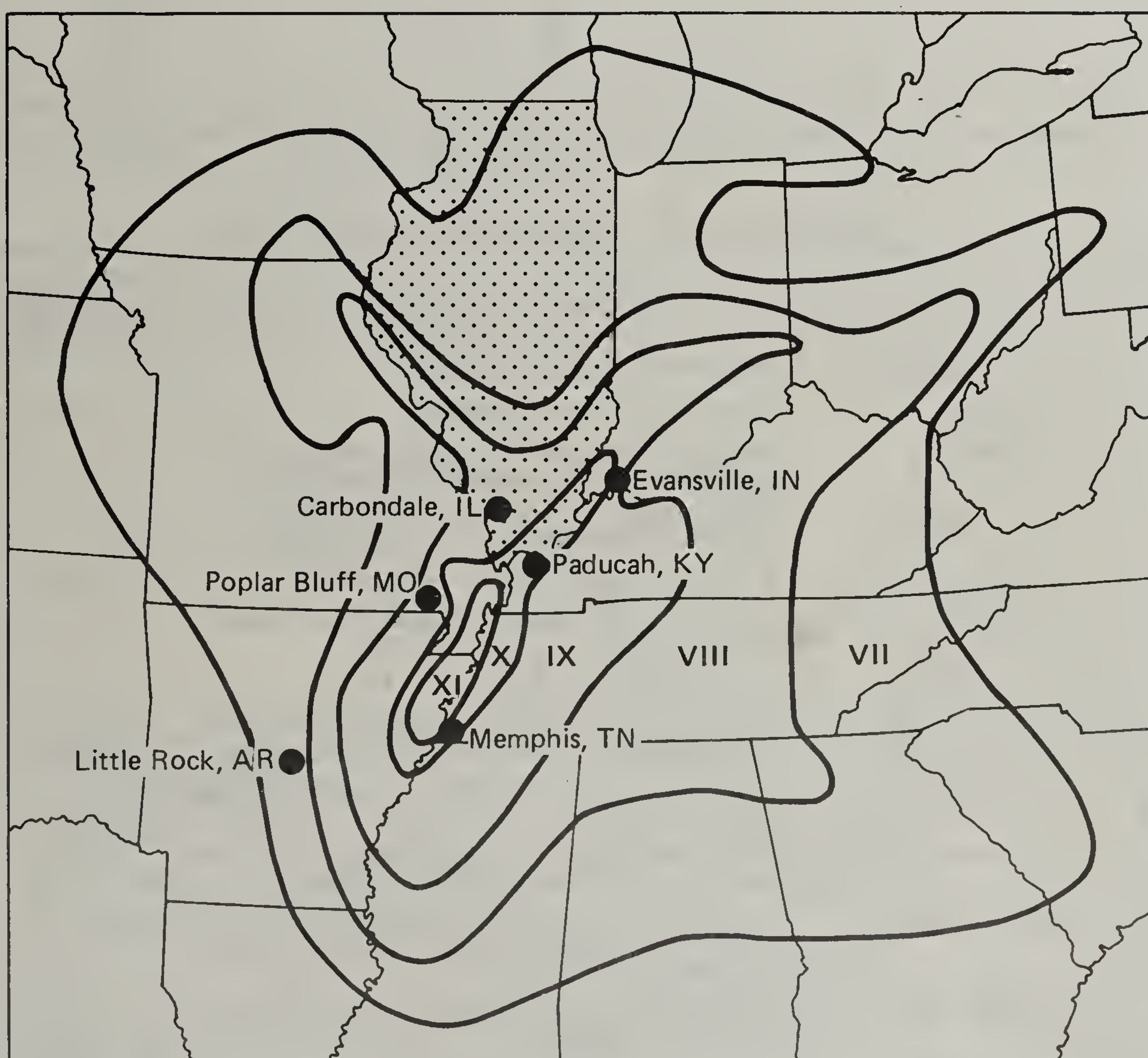
In the winter of 1811-12, three major earthquakes struck the area of New Madrid, Missouri, along the Mississippi River. No earthquake centered in Illinois during historic time has been as great. Between December and February, tremors were felt as far away as Washington, D.C. During that whole winter, nearly 2,000 more shocks occurred—all strong enough to be felt up to 200 miles away in Louisville, Kentucky.

The three strongest earthquakes were rated as "very disastrous" (see table). By the end of the winter, New Madrid was devastated. According to eyewitnesses, the ground rose in some places and subsided 20 feet or more in others. Large cracks appeared. Water spouts and sand plumes or "blows" erupted from the earth. Landslides were common, especially along the Mississippi River where banks collapsed into the water. In fact, the current flowed backward for a time, following an elevation in the riverbed. Fortunately, the region was sparsely populated.

A relic sand blow near Cairo, Illinois, indicates the strength or severity of the earthquake in southern Illinois. Today, a repeat of the New Madrid quakes would result in "ruinous damage" to parts of southern Illinois.

Since 1812, no shocks of this magnitude have occurred in the Midwest. One quake with an epicenter in the New Madrid area occurred in January 1843. Its maximum intensity was VIII on the Modified Mercalli Intensity Scale (see table). On this scale, VIII Is generally the lowest intensity associated with serious damage to manmade structures. Another quake in October 1895, also located in the New Madrid region, had an intensity of IX.

By contrast, earthquakes centered in Illinois have been infrequent and relatively mild—small shocks causing little or no damage. In fact, many historic earthquakes of Illinois (see map inside) are not connected to the New Madrid seismic zone.



Regional intensities (Mercalli Modified Intensity Scale) suggesting the possible effects of an earthquake as severe as the 1811 quake—if the epicenter occurred along the New Madrid seismic zone. Source USGS

FACTS ABOUT EARTHQUAKES

Earthquakes occur when rocks forming the earth's crust break—caused by the buildup of stresses greater than the strength of the rocks. Movement along the breaks is called *faulting.* When faulting takes place, the sudden release of energy produces vibrations or *seismic (shock) waves* that radiate from the main fault, often traveling long distances. These waves cause the shaking or "quaking" that lasts a few minutes to several hours, depending on what kinds of rocks they travel through and what paths they take. Where the faulting starts, at some depth below the Earth's surface, is the *focus* of an earthquake. The point on the surface directly above the focus is the *epicenter.*

Usually, the initial movement along the fault is relatively small. But after a short time, a much larger area shifts to relieve the main stress in the rocks. Although the time between the two events may be so brief that they cannot be felt separately, the initial shaking is called the *foreshock* and the principal break produces the *main shock.* As the surrounding rocks adjust, a series of *aftershocks* of decreasing magnitude and frequency usually occurs.

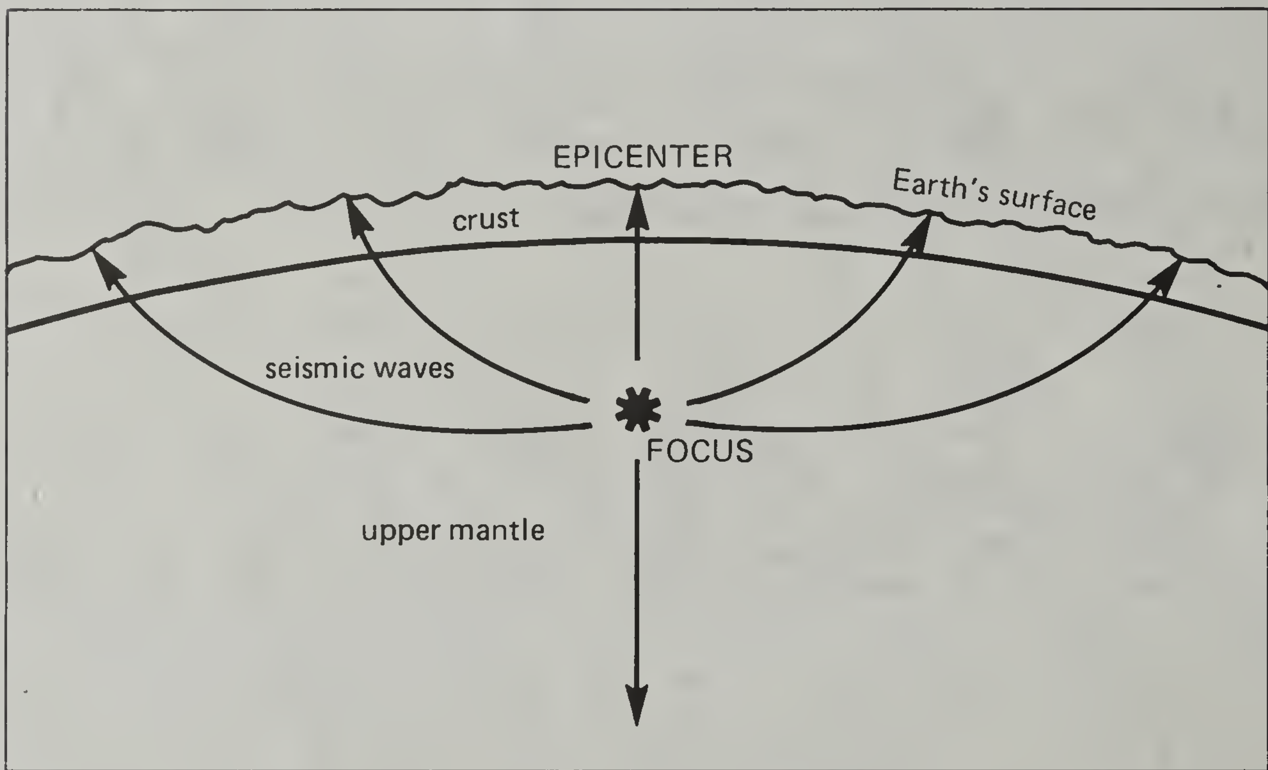
Magnitude and *intensity* are terms used to describe the severity of an earthquake, but they do not mean the same thing.

Magnitude is a measure of the total seismic energy released by rocks breaking and moving. Instruments called *seismographs* record the vibrations caused by ground movement. From these records, magnitude is calculated and expressed in Richter units. The Richter Scale is logarithmic, which means that magnitude 7 is many times greater than magnitude 6.

Intensity is an evaluation of the effects brought about by an earthquake, using the observations of people in the area affected:

- personal reactions (from disorientation to injury)
- property damage (from vibrating or overturned objects to collapsed structures)
- disturbances in land surface (from cracked ground to landslides)

Intensities are based on descriptive reports, rather than calculated from instrument readings. Values range from I to XII on the Modified Mercalli Intensity Scale (see table), increasing from barely detectable to catastrophic. For any earthquake, there will be many intensities, depending on location of observers—but only one magnitude.



* Adapted from Earthquakes: U.S. Department of the Interior/Geological Survey Brochure, 1981.

Modified Mercalli Scale of earthquake intensities

	Intensity	Characteristic effects	Richter Scale magnitude
I	Instrumental	detected only by seismography	
II	Feeble	noticed only by sensitive people	3.5-4.2
III	Slight	like the vibrations due to a passing heavy truck; felt by people at rest, especially on upper floors	
IV	Moderate	felt by people while walking; objects rock, including standing vehicles	
V	Rather strong	felt generally; most sleepers are awakened	4.3-4.8
VI	Strong	trees sway; suspended objects swing; loose objects overturn or fall	4.9-5.4
VII	Very strong	general alarm; walls crack; plaster falls	5.5-6.1
VIII	Destructive	masonry cracks; chimneys fall; poorly constructed buildings damaged; water well levels may change	6.2-6.9
IX	Ruinous	some houses collapse where ground begins to crack; pipes break open	
X	Disastrous	ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	7.0-7.3
XI	Very disastrous	few buildings remain standing; bridges destroyed; all services (railway, pipes, and cables) out of action; great landslides and floods	7.4-8.1
XII	Catastrophic	total destruction; objects thrown into air; ground rises and falls in waves	8.1+

*Adapted from Holmes, Arthur, 1965, Principles of Physical Geology: Ronald Press, NY, p. 901.

Earth materials transmitting seismic waves also contribute to earthquake effects. Damage to buildings, dams, highways, power lines, and similar structures only partly depends on the amount of energy released during faulting. Certain kinds of earth materials enhance the vibrations. In Illinois, structures built on thick, loose sediments of river floodplains are more likely to be damaged than structures on glacial till (dense, pebbly clay) or bedrock. In fact, seismic intensity may increase as much as one full unit on the Modified Mercalli Intensity Scale, if loose sediments are present. Also, loose sediments with a high moisture content can turn to liquid when shaken. Much remains to be learned about how different rocks and loose deposits can reduce or enhance the severity of ground shaking.

SEISMIC RESEARCH

The map of Illinois shows epicenters of historic earthquakes with intensities of V or greater. It also shows some major geologic structures in the bedrock. By mapping faults or folds, such as long arches *(anticlines)* and troughs *(synclines)*, geologists can pinpoint zones of weakness relatively near land surface. There is no evidence that any faults in these zones have moved in thousands of years.

To get information for mapping, geologists drill holes, take cores, and use various geophysical techniques. For example, they measure waves produced in subsurface earth materials by firing explosives placed in shotholes. In Illinois, rocks have been studied only to a depth of about 13,000 feet.

Seismologists calculate the depth of an earthquake's focus in terms of *miles* below the surface. On November 9, 1968, for instance, an earthquake in southeastern Illinois had a focal depth of 12 miles. Another quake, occurring on September 15, 1972, in north-central Illinois, probably had a focal depth of about 3.6 miles—although it could have been as deep as 9 miles. Even the shallower quake began miles below the sequence of rocks mapped by geologists.

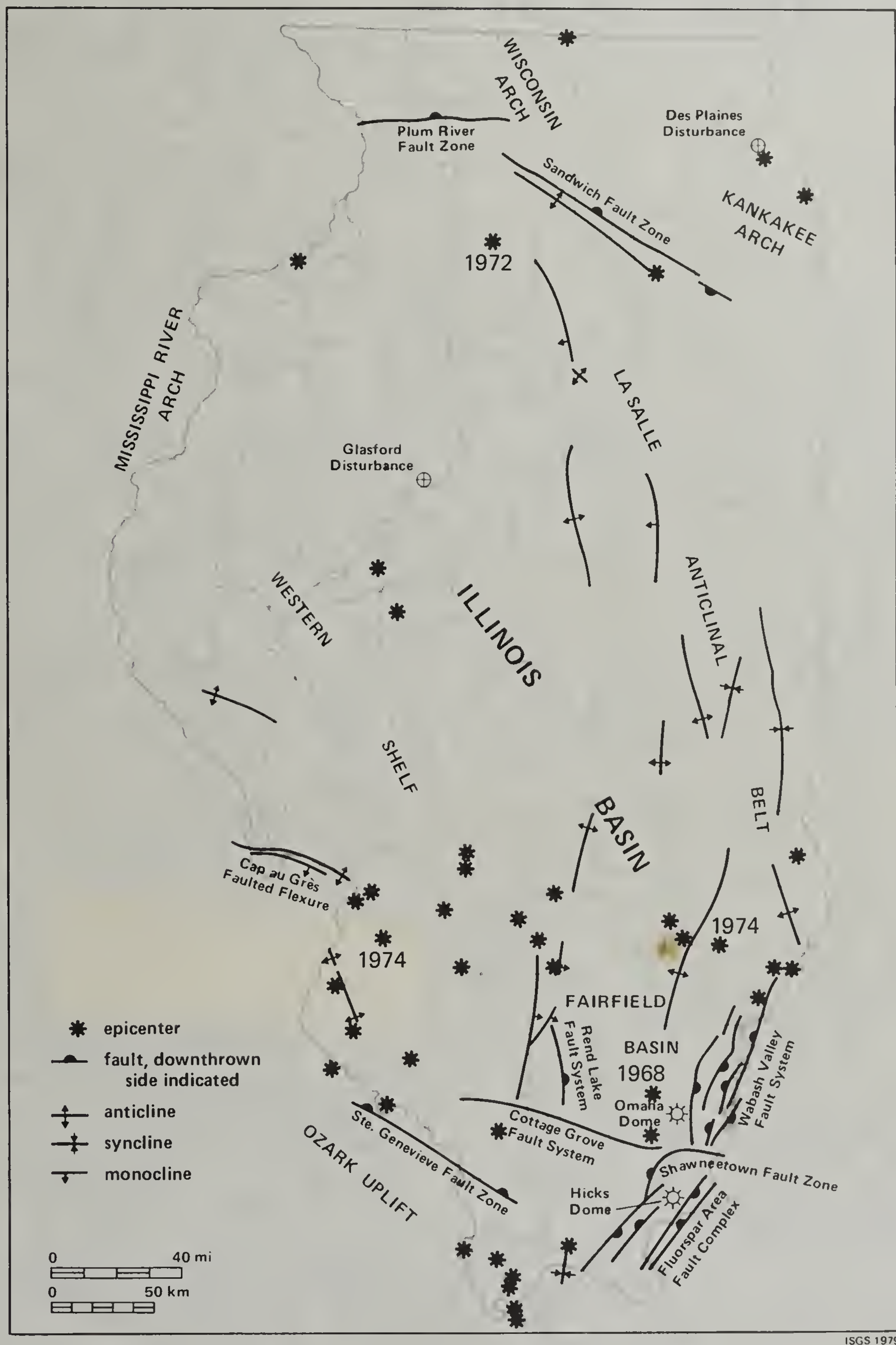
Because of the relatively uniform thickness of the Earth's crust in this part of the country, seismic energy radiating from shallow earthquake foci diminishes less rapidly than it does in the mountainous western states, where crustal thickness is less uniform. There is potential for damage over a greater area in the midcontinent.

Scientists continue to study the New Madrid seismic zone, the most active fault system in the Central Mississippi Valley. Using sensitive instruments to detect microearthquakes, researchers have been monitoring the area, collecting information, and putting together a detailed picture: the seismically active zone trends northeast from east-central Arkansas to the southern tip of Illinois in Alexander County and is approximately 120 miles long and 40 miles wide. Modern seismic surveying has confirmed that faulting in bedrock formations coincides with patterns of earthquake epicenters in southeastern Missouri. Scientists now believe that the New Madrid seismic zone is part of a deep rift in the Earth's crust extending northward from the Gulf of Mexico through the center of the Mississippi River Valley.

WHAT COULD HAPPEN IN ILLINOIS

Although earthquakes can occur *anywhere* in Illinois *at any time* (see map), most are likely to do little serious damage. The largest quakes to hit the state in historic times have been associated with the New Madrid seismic zone. In the 2000 years before 1811, according to geologic investigations made by the U.S. Geological Survey, two major earthquakes occurred in this fault zone. Apparently, recurrence time for an earthquake as severe as the quakes of 1811-12 is quite long. On the other hand, the U.S. Geological Survey estimates that enough strain energy has built up along the New Madrid fault zone since 1812 to produce shocks of 7.6 magnitude on the Richter Scale. Such an earthquake would be a disaster—disrupting services and utilities, destroying property, and causing great losses in lives.

What can we do to minimize the damage from earthquakes? How can we protect ourselves and our communities? What emergency services should we set up? Should we support scientific research into earthquakes and their effects? All these questions must be raised now. We are still a long way from being able to predict the time, place, and magnitude of future earthquakes. Yet we can be prepared.



ISGS 1979

This document is the first in a series of brochures on earthquake analysis and preparedness from the Illinois State Geological Survey and the Illinois Emergency Services and Disaster Agency. "Earthquakes in the Illinois Area" was prepared by Myrna M. Killey and Paul B. DuMontelle of the Engineering Geology Section, Illinois State Geological Survey.

The Central United States Earthquake Preparedness Project (CUSEPP), a 7-year regional project, was organized in 1982 to (1) inform the public about earthquakes and their possible effects, (2) develop emergency services and procedures, and (3) identify measures for minimizing damage that could be caused by earthquakes. In Illinois, the State Geological Survey is studying geologic, seismic, and other technical aspects of earthquakes. The Illinois Emergency Services and Disaster Agency is developing programs to help ensure public health and safety.

Illinois Emergency Services and Disaster Agency

ILLINOIS STATE GEOLOGICAL SURVEY 1905

Earthquakes in the Illinois area